

REMARKS

Claims 1 and 11-15 are cancelled; and claims 2-10 are amended. Claims 2-10 are pending in the application.

The specification is amended to correct a few minor typographical errors. Such corrections include corrections at page 2, lines 6 and 7, which addresses an objection to the specification raised by the Examiner. Applicant therefore requests that the Examiner's objection to the disclosure of the application be withdrawn in the Examiner's next action.

Fig. 6 has been amended to correct a couple of minor errors in the figure. The Examiner objected to Fig. 6 for utilizing the character "34" to designate both the sidewall and the source/drain region. Applicant's correction to Fig. 6 replaces the character "34" with the character "30" for designating the source/drain region. Applicant's correction to Fig. 6 also provides a line separating regions 14 and 18, which was inadvertently left out of the figure. Submitted herewith is a substitute drawing sheet 3 correcting Fig. 6, and a red-lined version of drawing sheet 3 showing changes in the substitute drawing sheet relative to the originally-submitted drawing sheet. Also submitted herewith is a letter to the PTO Official Draftsperson, requesting entry of the substitute drawing sheet into the application. Applicant respectfully requests that the Examiner approve the substitute drawing sheet for entry into the application, and then forward the substitute drawing sheet to the PTO Official Draftsperson, together with the letter and the red-lined drawing, so that the substitute drawing sheet can be officially entered into the application.

The Examiner objects to an Information Disclosure Statement submitted 8/6/01, and specifically contends that several publications listed in the statement are not in proper format for consideration, in that the publications do not appropriately specify a date of

publication. Submitted herewith is an information disclosure statement listing the publications, and specifying dates of publication of the references to indicate that the references published prior to applicant's filing of the present application. Also submitted herewith is the appropriate fee to have the references of the IDS considered at the present stage of prosecution of the present application. Applicant requests entry of the IDS, and consideration of the references submitted therewith. Applicant has not submitted copies of the references, since such copies were submitted with the originally-filed IDS that the Examiner is now objecting to. Applicant can, however, resubmit copies of the references if the Examiner so desires. The undersigned respectfully requests a phone call from the Examiner if the Examiner would like to have the references resubmitted.

The pending claims stand rejected as being either anticipated by Matsuda; or as being obvious in view of Lee in combination with Vossen; or being obvious in view of Lee in combination with Vossen and JP 60-167352. Amended claims 2-10 are believed allowable over the cited references.

Referring initially to claim 10, such recites a method of forming an assembly comprising silicon-doped aluminum oxide. The recited method includes co-evaporating aluminum oxide and silicon monoxide. The claim further recites that at least some of the evaporated aluminum oxide and silicon monoxide is deposited on a semiconductive material substrate to form the silicon-doped aluminum oxide on the substrate. Additionally, the claim recites that a conductive material is formed on the deposited silicon-doped aluminum oxide, with the conductive material being separated from the semiconductive material of the substrate by the silicon-doped aluminum oxide.

Amended claim 10 is believed allowable over the cited references for at least the reason that the references do not suggest or disclose all of the recited features of claim 10.

The Examiner is reminded that under MPEP § 706.02(j) three basic criteria must be met in combining references. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to combine the reference teachings. Second, there must be a reasonable expectation of success; and third, the combined references must teach or suggest all of the limitations in the claims. Also, the teaching or suggestion to make the claimed combination, and the reasonable expectation of success, must both be found in the prior art and not based on applicant's disclosure. In the present case, the cited references arguably do not teach all the recite features of claim 10. Further, even if all of the separate features of claim 10 could be found amongst the cited references, there is not sufficient motivation to combine the references to support a § 103 rejection based on the various references.

Initially, applicant notes that not one of the Examiner's cited references suggests or discloses the claim 10 recited deposition of co-evaporated aluminum oxide and silicon monoxide on a semiconductive material substrate to form silicon-doped aluminum oxide.

The Examiner cites Lee to show that silicon-doped aluminum oxide has been utilized as a gate dielectric, and cites one or both of Matsuda and Vossen to show that aluminum oxide and silicon monoxide can be generated by evaporation of source materials. However, missing from the cited references is any suggestion or disclosure of the claim 10 recited deposition of co-evaporated aluminum oxide and silicon monoxide on a semiconductive material substrate to form silicon-doped aluminum oxide. Applicant notes

that Vossen merely discloses that aluminum oxide and silicon oxide can be formed by evaporation, and contains no suggestion of formation of silicon-doped aluminum oxide through co-evaporation of aluminum oxide and silicon oxide. Applicant further notes that to the extent that Matsuda teaches anything about co-evaporation of aluminum oxide and silicon oxide, such is taught in the context of forming a barrier layer on a plastic film, and there is no suggestion within Matsuda that materials comprising aluminum oxide and silicon oxide would have application to the claim 10 recited assembly wherein the materials are formed over a semiconductive substrate in the form of silicon-doped aluminum oxide. For at least these reasons, all of the recited aspects of claim 10 are not disclosed or suggested in the cited references, and claim 10 is therefore allowable over such references.

Even assuming, for the sake of argument, that all of the various limitations of claim 10 can be considered to be found among the cited references, claim 10 is still allowable over such references in that there is not sufficient motivation for combining the references to create the recited subject matter of claim 10. As discussed above, Lee discloses a silicon-doped aluminum oxide. However, Lee does not disclose or suggest that such oxide would be formed through a claim 10 recited process utilizing co-evaporation of aluminum oxide and silicon oxide. The reference of Vossen discloses that aluminum oxide and silicon oxide can be formed through evaporation, but contains no disclosure or suggestion that co-evaporation of silicon oxide and aluminum oxide can be utilized to form a silicon-doped aluminum oxide; and it is inconceivable that any interpretation of Vossen could be construed which would reasonably teach the claim 10 recited co-evaporation of aluminum oxide and silicon monoxide to form a silicon-doped aluminum oxide deposit on a

semiconductive material substrate. The cites reference of Matsuda describes a material comprising aluminum oxide and silicon oxide, but does not teach or suggest that any of the methodology disclosed therein can be utilized for forming a silicon-doped aluminum oxide on a semiconductive material substrate.

The Examiner attempts to create motivation for utilizing the evaporative methods disclosed in Vossen for forming a silicon-doped aluminum oxide of the type described in Lee by stating that Lee teaches that any "conventional deposition technique such as sputtering" can be utilized to form the silicon-doped metal oxides utilized in structures described therein. Applicant respectfully requests that the Examiner reconsider his position. Applicant submits that the generic statement of Lee is not, by itself, sufficient to establish motivation to accomplish the claim 10 recited deposition of co-evaporated aluminum oxide and silicon oxide on a semiconductive material from Lee and Vossen. Specifically, Vossen does not contain any description of co-evaporation of aluminum oxide and silicon oxide. Instead, Vossen indicates that aluminum oxide can be evaporated, silicon oxide can be evaporated, and various constructions (which are not disclosed as being silicon oxide and aluminum oxide) can be formed as composite sputtering targets. The statement in Lee that conventional deposition techniques can be utilized for forming silicon-doped aluminum oxide does not provide motivation to modify the teachings of Vossen to create a method not specifically disclosed therein (co-evaporation of aluminum oxide and silicon oxide), and then utilize such method to form the silicon-doped aluminum oxide of Lee.

As there is no motivation within the Examiner's cited references of Vossen and Lee for co-evaporation of aluminum oxide and silicon oxide to form a silicon-doped aluminum

oxide over a semiconductive material, it appears that the Examiner is relying on applicant's own disclosure for the motivation to combine Vossen and Lee to describe the claim 10 recited co-evaporation of aluminum oxide and silicon oxide in forming a silicon-doped aluminum oxide deposit over a semiconductive material. Such utilization of applicant's disclosure is impermissible under the guidelines of MPEP 706.02(j).

The Examiner has not attempted to combine Lee with Matsuda for teaching any aspect of applicant's recited invention. For the record, applicant notes that there is not sufficient motivation to combine Lee with Matsuda to teach the claim 10 recited co-evaporation of aluminum oxide and silicon oxide to form a deposit on a semiconductive material substrate. Specifically, Matsuda describes compositions comprising aluminum oxide and silicon oxide in the context of utilizing the compositions as barrier layers over plastic films, and does not contain any suggestion that the compositions can be formed over a semiconductive material. Accordingly, there is no suggestion with Matsuda that the disclosed compositions of silicon oxide and aluminum oxide can be utilized in semiconductive material structures. Accordingly, the statement in Lee that conventional deposition techniques can be utilized for forming the doped metal oxides described therein cannot be fairly extended to include the methods of Matsuda, as the methods of Matsuda would not be considered conventional deposition techniques for forming doped metal oxides relative to semiconductor substrates.

Applicant has not addressed JP 60-167352 in the discussion above. The Japanese reference is cited by the Examiner to show that sapphire has previously been utilized in alumina deposition. The Japanese reference does not disclose or suggest the claim 10 recited co-evaporation of aluminum oxide and silicon oxide to form a deposit over a

semiconductive material; nor does it provide motivation for forming any combination of the Examiner's cited references to suggest the claim 10 recited co-evaporation of aluminum oxide and silicon oxide in forming a deposit over a semiconductive material substrate.

For the above-discussed reasons, amended claim 10 is allowable over any and all combinations of the references cited by the Examiner. Applicant therefore requests formal allowance of claim 10 in the Examiner's next action.

Applicant notes that the Examiner indicated in the second full paragraph of page 6 of the Office Action that applicant could overcome a rejection based on Lee and Vossen if applicant provides evidence that the silicon-doped aluminum oxide formed by applicant's claimed invention provides unexpected results relative to the silicon-doped aluminum oxide film described in Lee. Applicant appreciates the courtesy extended by the Examiner in the Examiner's attempt to assist applicant in developing a strategy for overcoming the rejection based on Lee and Vossen. However, applicant respectfully submits that since claim 10 is a method claim, applicant is not required to show any unexpected advantage of products formed by the claimed method relative to prior art products in order to obtain allowance of the method. In other words, even if the claim 10 recited method produced a product identical to products previously known in the art, the method of claim 10 can still be allowable on its own merits (i.e. is still allowable provided that the method is novel and non-obvious relative to prior art methods of forming the prior art product). Accordingly, there is no requirement that applicant show that the product formed by the claim 10 recited method is different than the prior art product of Lee to obtain allowance of the claim 10 recited method. Applicant submits that the method of claim 10 is allowable over the cited references on its own merits, and specifically that the references do not suggest or disclose

the recited process of co-evaporation of silicon oxide and aluminum oxide to form a deposit over a semiconductive material substrate. Applicant therefore requests formal allowance of claim 10 in the Examiner's next action.

Claims 2-9 are amended so that the claims now depend from claim 10. Accordingly, claims 2-9 are allowable for at least the reasons discussed above regarding claim 10.

Claims 2-10 are allowable for the reasons discussed above. Applicant therefore requests formal allowance of claims 2-10 in the Examiner's next action.

Respectfully submitted,

Dated: _____

4/23/02

By: _____



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Enclosures: Substitute Fig. 6; red-lined drawing showing corrections to Fig. 6; Letter to the PTO
Official Draftsperson; Information Disclosure Statement

Application Serial No.09/754,926
Filing Date 1/4/01
Inventor.....Ahn et al.
Assignee.....Micron Technology, Inc.
Group Art Unit.....2813
Examiner E. Kielin
Attorney's Docket No.MI22-1533
Title: Methods of Forming Assemblies Comprising Silicon-Doped Aluminum Oxide

VERSION WITH MARKINGS TO SHOW CHANGES MADE ACCOMPANYING
RESPONSE TO FEBRUARY 27, 2002 OFFICE ACTION

In the Specification

The replacement specification paragraphs incorporate the following amendments.

Underlines indicate insertions and ~~strikeouts~~ indicate deletions.

The title has been amended as follows:

Methods of Forming Assemblies Comprising Silicon-Doped Aluminum Oxide
~~Methods of Forming Silicon-Doped Aluminum Oxide, and Methods of Forming Transistors~~
~~and Memory Devices~~

The paragraph beginning at line 16 on page 2 has been amended as follows:

Of the listed high-k materials, aluminum oxide has received significant interest. Aluminum oxide has been used as a high-k inter-poly dielectric (IPD) for low voltage/high speed flash memories. Specifically, it has been shown that 10 nanometer thick Al₂O₃, with k of about 10, can reduce an erasing time by three orders of magnitude in comparison with 15 nanometer thick ONO (with ONO referring to a sandwich of silicon dioxide, silicon

nitride, and silicon dioxide). The ONO has a k of about 10. Aluminum oxide can reduce the erasing of voltage of a flash memory device by about 40% compared with silicon dioxide, and about 27% compared with ONO of the same thickness as the aluminum oxide.

The paragraph beginning at line 18 on page 11 has been amended as follows:

The evaporation of silicon monoxide can be readily accomplished. Silicon monoxide can be evaporated from a thermal source and deposited onto a "cold" (room temperature) substrate with good adhesion. Silicon monoxide films formed by thermal evaporation have many attractive optical, electrical, mechanical and thermal properties, which can make it the films suitable for many semiconductor applications. For instance, silicon monoxide can be thermally evaporated at much lower temperatures than silicon, silicon dioxide, or silicon nitride (Si_3N_4), and it condenses on cooler substrates in a uniform and adherent stoichiometric silicon monoxide film when evaporated at high vacuum. In fact, before the present day technology of silicon dioxide deposition by CVD (chemical vapor deposition), and when sputtering was not available, silicon monoxide was deposited by thermal evaporation and subsequently oxidized for rapid thermal oxidation. Such technique demonstrated the possibility of converting silicon monoxide deposited at room temperature to silicon dioxide by rapid thermal annealing at 700°C to $1,100^\circ\text{C}$, but with a duration of only a few seconds, as compared with the ordinary thermal oxidation which takes a period ranging from 30 to 60 minutes at $1,000^\circ\text{C}$.

The paragraph beginning at line 14 on page 12 has been amended as follows:

Another aspect of silicon monoxide chemistry is that it has been shown that the production of silicon dioxide films on a large substrate area by ion deposition of silicon monoxide can be accomplished. For instance, silicon dioxide films can be produced by active evaporation of silicon monoxide with oxygen assisted deposition (IAD). In addition to the benefits of ion bombardment on film properties, this approach can offer attractive advantages over electron beam evaporation of silicon dioxide. For instance, the evaporation source can be relatively cheap, simple, and ~~easier~~ easy to control. The production of silicon dioxide films on over 41 inches diameter by resistance evaporation of silicon monoxide and simultaneous oxygen ion bombardment from a cold cathode ion source has also been achieved. Additionally, processes have been developed to convert silicon monoxide to silicon dioxide during deposition by the use of an ion beam. However, additional oxygen should be supplied in a sufficiently energetic process to provide the material conversion during or after the silicon monoxide deposition on the surface.

In the Claims

The claims have been amended as follows. Underlines indicate insertions and ~~strikeouts~~ indicate deletions.

Claims 1 and 11-15 are cancelled.

2. (Amended) The method of claim 4 10 wherein the co-evaporating and depositing are conducted in a chamber, and wherein there is no O₂ flowed into the chamber during the co-evaporation and deposition.

3. (Amended) The method of claim 4 10 wherein the co-evaporating comprises thermal evaporation of the aluminum oxide from single crystal sapphire.

4. (Amended) The method of claim 4 10 wherein the co-evaporating comprises thermal evaporation of the silicon monoxide.

5. (Amended) The method of claim 4 10 wherein the co-evaporating comprises ion beam evaporation of the aluminum oxide.

6. (Amended) The method of claim 4 10 wherein the co-evaporating comprises electron gun evaporation of the aluminum oxide.

7. (Amended) The method of claim 4 10 wherein the co-evaporating comprises:

thermal evaporation of the silicon monoxide; and

one or both of electron gun evaporation and ion beam evaporation of the aluminum oxide.

8. (Amended) The method of claim 4 10 wherein the substrate comprises silicon.

9. (Amended) The method of claim 4 10 wherein the substrate comprises monocrystalline silicon.

10. (Amended) ~~The method of claim 1 wherein the substrate comprises a semiconductive material, and further comprising~~ A method of forming an assembly comprising silicon-doped aluminum oxide, comprising:

co-evaporating aluminum oxide and silicon monoxide;
depositing at least some of the evaporated aluminum oxide and silicon monoxide on a semiconductive material substrate to form the silicon-doped aluminum oxide on the substrate; and

forming a conductive material on the deposited silicon-doped aluminum oxide; ,
the conductive material being separated from the semiconductive material of the substrate by the silicon-doped aluminum oxide.

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